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(71) Anmelder:
Linde AG, 65189 Wiesbaden, DE

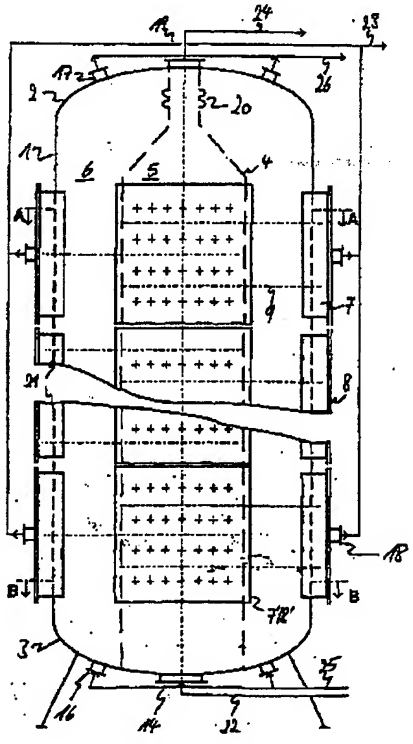
(72) Erfinder:
Götz, Reiner, Dipl.-Ing. Dr.-Ing., 81477 München, DE; Lahne, Ulrich, Dipl.-Ing., 82041 Deisenhofen, DE; Muschelknautz, Sebastian, Dipl.-Ing. Dr.-Ing., 81479 München, DE

(66) Für die Beurteilung der Patentfähigkeit in Betracht zu ziehende Druckschriften:
NICHTS ERMITTELT

Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

(54) Separator zur Erzeugung von Sauerstoff

(57) Es wird ein Separator, der insbesondere für die Erzeugung von Sauerstoff geeignet ist, beschrieben.
Der erfindungsgemäße Separator ermöglicht die Realisierung eines Separators mit einer nahezu beliebig großen Leistung, wobei eine ausreichende Kühlung sämtlicher stark druckbelasteter metallischer Bauteile realisiert werden kann. Ferner wird ein sicherer und gasdichter Übergang von dem als Membranrohr ausgebildeten Bereich eines Rohres zu den metallischen Bauteilen des Rohres gewährleistet. Des Weiteren können schadhafte Rohre vergleichsweise einfach und schnell ausgewechselt werden.



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Applicant:
Linde AG, 65189 Wiesbaden, DE

Inventors:
R. Götz
Certified Engineer, Doctor of Engineering, et al.

Documents to be taken into consideration for evaluating the patentability:
NOTHING FOUND

Separator For Generating Oxygen

A separator is described which is especially suitable for the generation of oxygen.

The separator in accordance with the invention makes it possible to achieve a separator with an arbitrarily high performance, wherein adequate cooling of all pressure-loaded metal components can be achieved. Furthermore, a safe and gas-tight transition from the area of a pipe designed as a membrane pipe to the metal constituents of the pipe is guaranteed. Furthermore, damaged pipes can be replaced relatively simply and rapidly.

Specifications

[0001] The invention pertains to a separator which is designed in particular for the generation of oxygen.

[0002] For generating oxygen, a gas-tight, oxygen ion- and electron-conducting ceramic membrane is supplied on one side (retentate side) with an oxygen-containing gas mixture. On the other side of the membrane (permeate side), pure oxygen can then be removed.

[0003] However, the oxygen ion transport through such ceramic membranes takes place in the desired direction only if the oxygen partial pressure on the retentate side is greater than on the permeate side. In the production of pure oxygen this can be achieved in that the oxygen-containing gas mixture introduced to the ceramic membrane is compressed and/or a pressure reduction on the permeate side—thus of the pure oxygen to be obtained—is achieved.

[0004] The optimal operating or efficacy range of available ceramic membranes lies at temperatures between 700°C and 1100°C.

[0005] From German patent application 100 29 882.6 a separator is known for the production of oxygen in which a plurality of membrane pipes suspended in a pipe plate are arranged in parallel to the longitudinal axis of the separator. By means of a suitable guidance of a cooling air stream, it is accomplished in this separator construction that all highly pressure-loaded metal components are adequately cooled.

[0006] However, the performance of this separator design is limited on one hand by the length of the membrane pipe and on the other hand by the diameter of the container. This means that to reach certain performances, several separators must be connected together, which result in a high space requirement and considerable costs for the pipelines connecting the individual separators. It is also indispensable that some components of this separator must be made of high temperature-resistant special steels. Furthermore it is generally necessary for the separator jacket, which may be exposed to a relatively high pressure load, either to be provided with a thermal insulating layer on its inside to lower the temperature level or likewise be made of a special steel. If a thermal insulating layer is provided, furthermore a so-called out of skin temperature monitoring is required.

[0007] Furthermore it may be necessary that turbulence enhancers be provided in the areas of the gas space surrounding the membrane pipes. Theoretically, in the separator design described in German patent application 100 29 882.6 a uniform gas flow in the gas spaces can be achieved

only with difficulty or with a relatively high technical expense because of the radial introduction and removal of the gas streams and the relatively low ratio of height to diameter of the gas spaces.

[0008] The goal of the present invention is to provide a separator for the generation of oxygen that avoids the drawbacks mentioned.

[0009] To accomplish this goal, a separator is suggested

--with a separator jacket

--with a shaft arranged concentrically in the separator jacket defining a gas space

--with 2 caps closing the 2 ends of the separator jacket

--wherein each cap has at least 2 openings

--wherein at least 1 opening of each cap is assigned to the shaft and at least in each case 1 opening of each cap is assigned to the outer gas space defined by the shaft and the separator jacket, with at least 1 area of the separator jacket that is designed as a pipe plate

--with at least 1 chamber covering these areas or this area of the separator jacket, having at least 1 opening

--with at least 1 pipe fastened in the pipe plate, essentially arranged perpendicular to the separator jacket

--wherein the pipe or pipes extend through openings arranged in the wall of the shaft into the inner gas space

--at least partially designed as membrane pipes

--and the area of the pipe or pipes designed as a membrane pipe is preferably arranged in the inner gas space.

[0010] Additional advantageous embodiments of the separator in accordance with the invention are objects of the subclaims.

[0011] The separator in accordance with the invention and additional designs thereof will be explained in greater detail on the basis of the exemplified embodiment shown in Figures 1 to 4.

[0012] These show the following:

[0013] Figure 1 a lateral sectional view through a possible embodiment of the separator in accordance with the invention. Figure 2. A sectional view along A-A of the embodiment shown in Figure 1. Figure 3. A sectional view along line B-B through the embodiment shown in Figure 1. Figure 4. Design and arrangement of a membrane pipe.

[0014] Such separators—as shown in Figure 1—are usually cylindrically symmetric in design. They can be arranged either upright or in any other direction, for example horizontal. In the following, the upright arrangement shown in Figure 1 will be described.

[0015] The separator consists of a separator jacket 1 (in the following called merely "jacket"

and two caps 2 and 3 that close both ends of the jacket 1. Each jacket 2 and 3 has at least two openings 14 and 16 or 17 and 19. In practice the lower cap 3—in contrast to the representation in Figure 1—is designed only as a plate.

[0016] Within the jacket 1, a concentrically arranged shaft 4, which defines an inner gas space 5, is provided. Through this shaft 4 as well as the jacket 1, an additional external gas space 6 is defined. In each case at least one opening of each cap 2 and 3 is arranged in the inner gas space 5—these are the openings 14 and 19—or the outer gas space 6—these are the openings 16 and 17.

[0017] On the circumference of the jacket 1, in several stages, chambers 7 and 7′ are provided; these can for example—as shown in Figure 1—have a square cross-section. These chambers 7 and 7′ are preferably provided with a removable cap 8 or 8′.

[0018] In the area of these chambers 7 and 7′, the jacket 1 is designed as a pipe plate 21. In this area of the jacket 1 designed as a pipe plate 21, a plurality of pipes are inserted, wherein these are now arranged essentially perpendicular to the jacket 1.

[0019] Through this arrangement of the pipes 9—thus essentially perpendicular to the jacket 1 or the longitudinal axis of the separator—its length no longer has any limiting influence on the maximal performance of the separator in accordance with the invention. Since in principle any arbitrary number of pipes 9 or layers of pipes 9 can be arranged one on top of the other, a great performance can be achieved with only a single tower-type separator.

[0020] To accommodate the pipes 9, the pipe plates 21 preferably have pipe pieces 10, which are welded into them and into which the pipes 9 are inserted. The pipes 9 inserted in this way are tightly welded to the pipe pieces 10. If defective pipes 9 must be replaced, these can be removed from the pipe base 21 after removal of the weld seam. However, the welding described is not absolutely necessary, since in certain circumstances it is possible to avoid a fixed connection altogether or alternative connecting methods other than welding can be employed.

[0021] The pipes 9 extend over the outer gas space 6 through openings 11 provided in the shaft wall 4 into the inner gas space 5. Here, the pipes 9 preferably extend over the entire width of the inner gas space 5.

[0022] The pipes 9 in the area of the openings 11 provided in the shaft wall 4 for the purpose of sealing preferably have metal bellows 12 introduced, wherein these are fastened with one of their ends to the pipes 9, preferably gas tight. In this case also the fastening preferably takes place by means of welding, but here also alternative connecting methods are conceivable. The pipes 9 are thus fixed in a sliding manner in the area of the openings 11. The provision of a metal bellows 12 permits adequate securing against large leakages between the outer gas space 6 and the inner gas space 5, since the metal bellows 12 lie with their open ends on the wall of the shaft 4. It is also conceivable that the open ends of metal bellows 12 are connected with the wall of the shaft 4 by

means of a suitable mechanism.

[0023] As shown in Figure 4, the pipes 9 are at least partially designed as membrane pipes 13. In this process, the area of the pipe 9 formed as a membrane pipe 13 is arranged in the inner gas space 5. It is also conceivable that the area of the pipe 9 formed as a membrane pipe 13 also extends into the outer gas space 6.

[0024] The area of the pipe formed as a membrane pipe 13 can be made either in the form of a gas-tight, oxygen ion- and electron-conducting ceramic membrane applied to a gas-permeable support pipe or in the form of a monolithic, gas-tight, oxygen ion- and electron-conducting ceramic pipe.

[0025] In the pipe 9 shown in Figure 4, the area of the pipe 9 designed as a membrane pipe 13 is connected at each of its ends with one metal pipe each of approximately the same diameter, in a material-locking and coaxial manner. The pipes 9 are fixed only at one of their ends in the pipe base 21 or the jacket 1, where in each case the respectively other end, to be sure, is closed gas-tight, but is arranged freely expandable in the axial direction to avoid stresses due to differences in thermal expansions. Not shown in Figure 4 is a suitable holder for the freely expandable end of the pipe 9 [0026] Figures 2 and 3 show two sectional representations along the line A-A (Figure 2) and along line B-B (Figure 3) of the embodiment shown in Figure 1.

[0027] Clearly recognizable are the aforementioned chambers 7 and 7′, which are arranged on the circumference of the jacket 1 in several levels.

[0028] It is not urgently necessary that the chambers 7 and 7′ shown in Figures 1 to 3 are used; instead it is adequate if at least those areas of the jacket 1 that are designed as pipe plates 21 are covered by a chamber, wherein this chamber must have at least one opening. The required openings are provided in Figures 1 to 3 with reference Figure 18.

[0029] On the basis of Figure 1 the operation of the separator in accordance with the invention and the exemplified embodiment shown in Figures 1 to 3 will be explained in further detail.

[0030] A hot, oxygen-containing gas mixture is conveyed to the separator in accordance with the invention over a pipeline 22 and the opening provided in the bottom plate 3 to the shaft 4. The oxygen-containing gas mixture at a pressure of 15 bar has a temperature of 850°C. The production of such as gas mixture can for example take place in a combustion chamber under an excess of fresh air. This gas mixture now flows around the area of the pipe 9 formed as a membrane pipe 13 and extending into the shaft 4. In this process pure oxygen enters the interior 15 of the pipe 9 in which the oxygen partial pressure with a value of for example 0.2 bar is substantially lower than in the shaft 4. The oxygen entering the interior 15 of the shaft 9 is removed from the pipes 9 and cooled to a temperature of about 250°C.

[0031] This cooling is achieved by the fact that over the pipeline 25 and the openings 16, fresh air, which has a temperature of 130°C at a pressure of 15.5 bar, is introduced into the outer gas

space 6. The air heated to a temperature of about 250°C against the hot oxygen stream to be cooled in the interior 15 of the pipe 9 is then withdrawn through the opening 17 and over the pipeline 26 from the separator and if desired conveyed to the previously mentioned combustion chamber for the purpose of generating the oxygen-containing gas mixture.

[0032] From the chambers 7 and 7′, the pure oxygen stream cooled in this way is withdrawn at a pressure of 0.2 bar and a temperature averaging 250°C over the opening 18 arranged in the caps 8 and 8′ as well as the pipeline 23. From the shaft 4 over the opening 19 and over pipeline 24, an oxygen-depleted hot gas mixture is withdrawn and if desired conveyed for further energy utilization.

[0033] The pipe plate 21, which is exposed to a pressure difference of 15.3 bar, is heated in the separator design according to the invention to a maximal temperature of 250°C.

[0034] In the separator design in accordance with the invention, the higher pressure also prevails on the outside of pipe 9. This is advantageous, since in general the pressure resistance of ceramic is higher than its tensile strength.

[0035] Further developing the separator in accordance with the invention it is suggested that on the inside of the shift 4 and/or on the outside of the separator jacket 1 a thermal insulating layer is arranged.

[0036] In contrast to the separator design described in German patent application 100 29 882.6, the provision of a thermal insulating layer on the inside of the jacket 1 is not required even if this is not made of special steel. If a thermal insulating layer is arranged on the inside of the shaft 4, this need not be made of a special steel. However in the usual case the pipes 9 must be made of a special steel because of the corresponding high temperature.

[0037] An additional advantageous embodiment of the separator in accordance with the invention is characterized in that means for compensating for the different axial thermal expansions of the shaft 4 and the jacket 1 are provided.

[0038] These means can be designed for example in the form of a compensator 20 as shown in Figure 1.

[0039] The separator in accordance with the invention creates a design in which the length of the membrane pipe no longer has a limiting influence on the performance of the separator. Because of the high gas velocities achieved both in the gas space 5 and in the gas space 6 and the pipe through which a transverse flow is taking place, high heat and material flows are guaranteed, so that the use of turbulence enhancers is not necessary. The gas flow that is uniform over the entire flow cross-sections can be guaranteed in the aforementioned gas spaces without increased technical expense.

[0040] The separator in accordance with the invention also permits the realization of an adequate cooling of all highly pressure loaded metal components. Furthermore, a safe and gas-

tight transition from the area of a pipe designed as a membrane pipe to the metal component of the pipe is guaranteed. In addition, damaged pipes can be replaced relatively easily and rapidly. Furthermore the separator in accordance with the invention is designed as conventionally as possible, so that the number of ceramic components can be minimized.

[0041] In addition to the membrane types mentioned, the separator in accordance with the invention is also suitable for the use of other membranes that can be integrated into the separator design in the manner described.

Claims

1. Separator

With a separator jacket (1).

With a shaft (4) arranged concentrically in the separator jacket (1), defining an inner gas space (5)

With two caps (2,3) closing the two ends of the separator jacket (1), wherein each cap (2,3) has at least two openings (14, 16, 17, 19)

Wherein at least one opening (14, 19) of each cap (2, 3) is assigned to the shaft (4) and at least one opening (16, 17) of each cap (2, 3) is assigned to the outer gas space (6) defined by the shaft (4) and the separator jacket (1),

With at least one area of the separator jacket (1) that is designed as a pipe base (21),

With at least one chamber (7, 7') covering this area or these areas of the separator jacket (1), having at least one opening (18),

With at least one pipe (9) fastened in the pipe space (21) and arranged essentially perpendicular to the separator jacket (1), wherein the pipe or pipes (9) extend through openings (11) arranged in the wall of the shaft (4) into the inner gas space (5)

At least partially are designed as membrane pipes (13) and the area of the pipe or pipes (9) designed as a membrane pipe (13) both preferably arranged in the inner gas space (5).

2. Separator according to claim 1, characterized in that the area of the pipe (9) formed as a membrane pipe (13) is designed in the form of a gas-tight, oxygen ion- and electron-conducting ceramic membrane applied to a gas-permeable support pipe.
3. Separator in accordance with claim 1, characterized in that the area of the pipe (9) formed as a membrane pipe (13) is designed in the form of a pipe consisting of a monolithic, gas-tight, oxygen ion- and electron-conducting ceramic.
4. Separator in accordance with one of the preceding claims, characterized in that in the area of the separator jacket (1) designed as a pipe plate (21), pipe pieces (11) are arranged, to which the pipe (9) can be fastened.
5. Separator in accordance with one of the preceding claims, characterized in that in the

area of the openings (11) arranged in the walls of the shaft (4), the pipes (9) have metal bellows (12) arranged on them, wherein these are fastened with one of their ends to the pipes (9), preferably gas tight.

6. Separator in accordance with one of the preceding claims, characterized in that the area or areas of the separator jacket (1) that are designed as pipe plates (21) covering chambers (7, 7′) have a removable cap (8, 8′).
7. Separator in accordance with one of the preceding claims, characterized in that means for compensating for the axial thermal expansion of the shaft (4) are provided.
8. Separator in accordance with one of the preceding claims, characterized in that the separator is designed in a cylindrically symmetrical manner.

Three (3) pages of drawings attached.

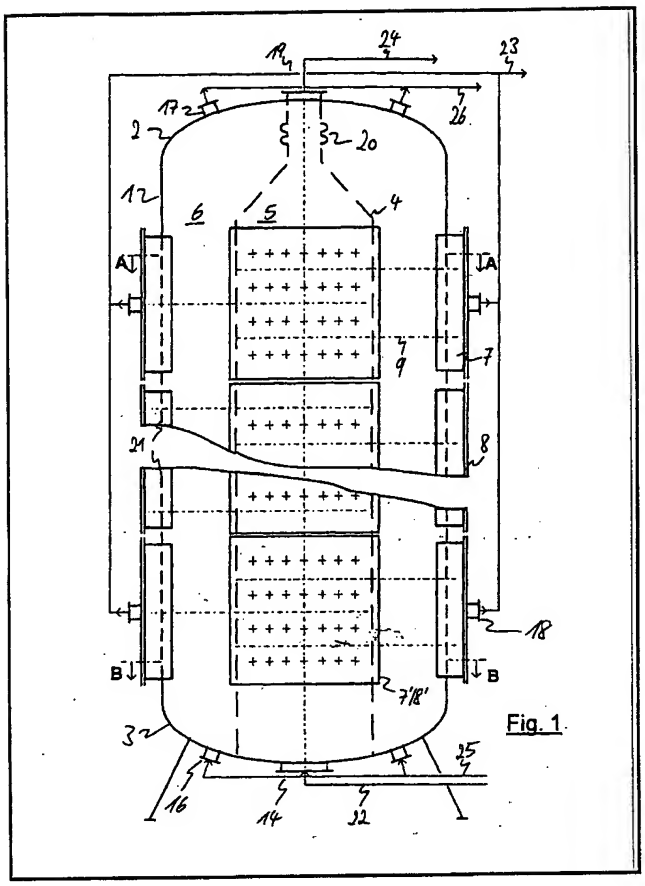
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Fig. 1

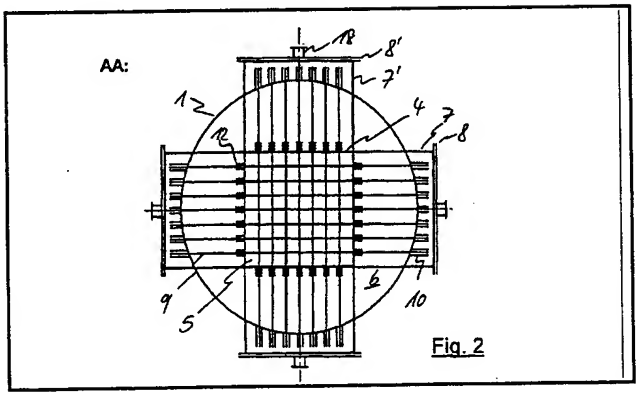
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Fig. 2

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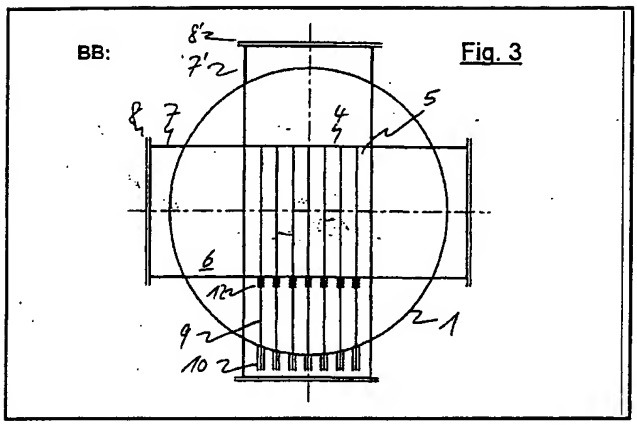

Fig. 3

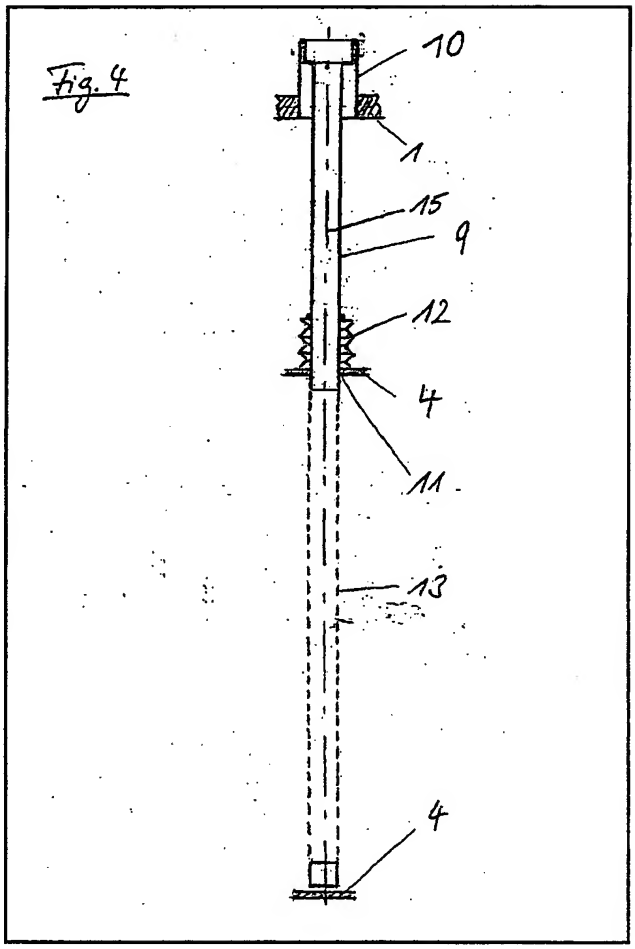

Fig. 4

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